Space Weather Technical Forecast

Issued on Friday, 31 December 2021 at 00:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of G1/Minor storm, mainly on Day 2.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was very low, with no C-class flares observed in the last 24 hours. There are four sunspot regions on the visible disc, with the mature region AR2916 (Eki/beta) being the largest and presenting the most likely potential for future flares. The remaining regions are either weak or fading. No Earth-bound CMEs currently feature in the forecast.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1, have been mostly slightly elevated to elevated with a peak of 517 km/s noted at 30/1237 UTC. Density was generally around average but started above average before falling by 30/0036UTC. A peak of 33ppcc at 30/0010UTC. Total magnetic field strength was mostly weak but was moderate until 30/0829UTC and observed to be strong until 30/0109UTC, with a peak of 21nT at 30/0035UTC. The north-south component, Bz, varied generally weakly, but reached a positive peak of 18nT at 30/0040UTC and a negative peak of -11nT at 30/0109UTC. These observations suggest that the first peak was the glancing CME and the second was the high speed stream. Phi angle was rather indeterminate in orientation with a spell of negative between 30/0400UTC and 30/0600UTC, and then from 30/1000UTC until 30/1430 UTC and again after 30/2100 UTC. Geomagnetic activity has been Quiet throughout (Kp1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at background levels. The high energy electron flux (greater than 2 MeV) was at background to moderate levels. Electron fluence values remained well below Active threshold (1e8 integrated pfu) throughout. Observed fluence at 30/0000UTC was 3.65e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low or very low solar activity is likely over the next four days, with a slight chance of moderate activity due to AR2916 in the southwest quadrant.

Solar Wind / Geomagnetic Activity: A current high speed stream (HSS) from coronal hole 39 is expected decline over the next 24 hours, before a further high speed stream from coronal hole 40 probably connects on day 2 (01 January), and this may give solar winds around 500km/s. Geomagnetic activity is expected to be mainly Quiet, with a slight chance of Active or G1/Minor Storms due to the connection with the HSS on 01 January.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, albeit with a very slight chance of S1 should there be any significant flare activity. High energy electron flux levels are expected to reach moderate levels through the period, although given the relatively modest high speed stream high (1e3pfu) levels are considered unlikely. Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

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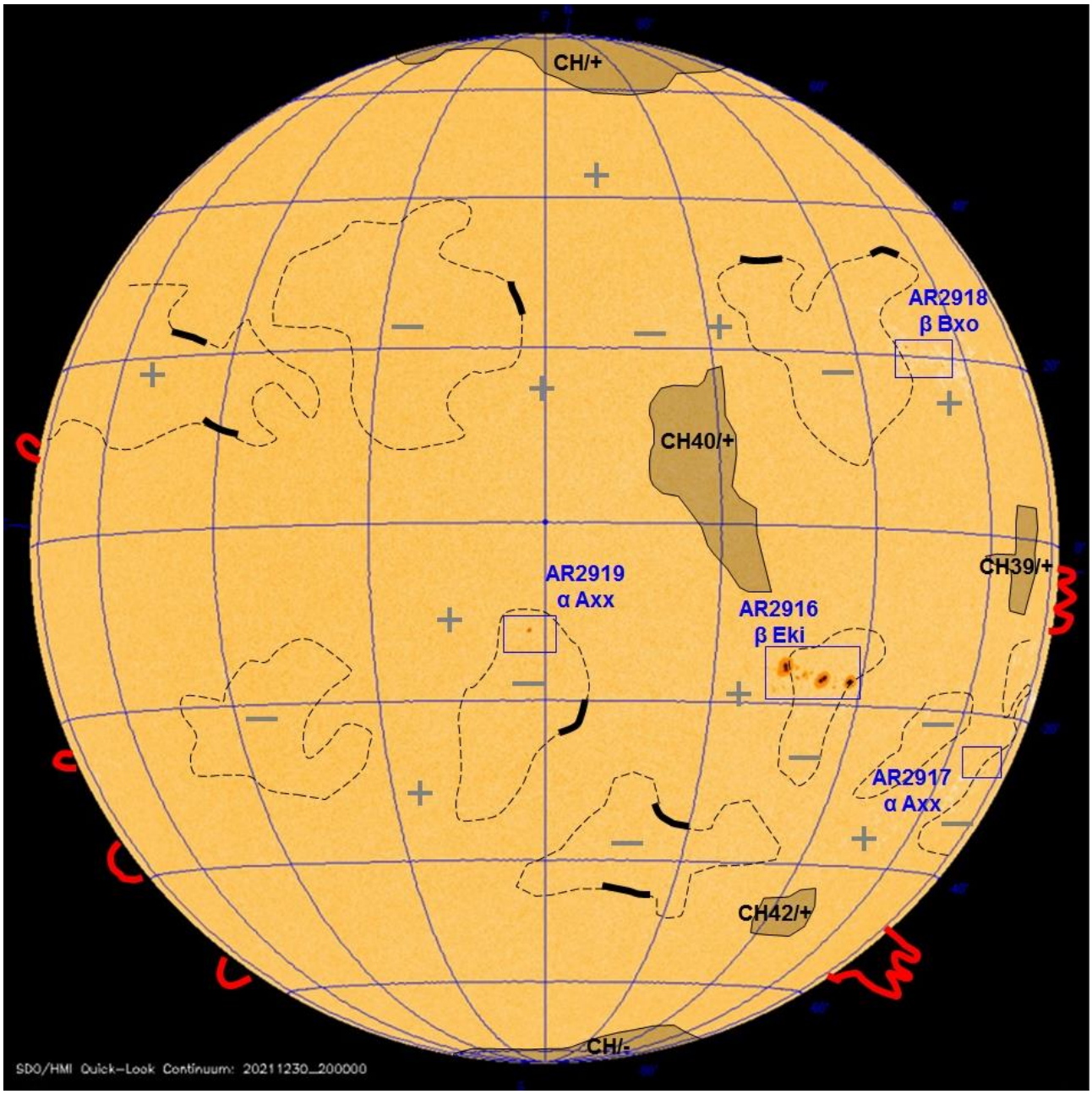
Figure 1. Solar Analysis Valid 2000UTC, 30 December 2021.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The high speed stream from coronal hole 39 is currently connected with the Earth, giving observed speeds of around 450km/s. This is expected to continue through the next 24 hours (31 December) as the coronal hole moves towards the western limb. Coronal hole 40, which is a recurrent feature, is then forecast to connect with the Earth on 01 January, and is forecast to reach around 500km/s, with a gradual decline probably underway during Day 4 (3 January).

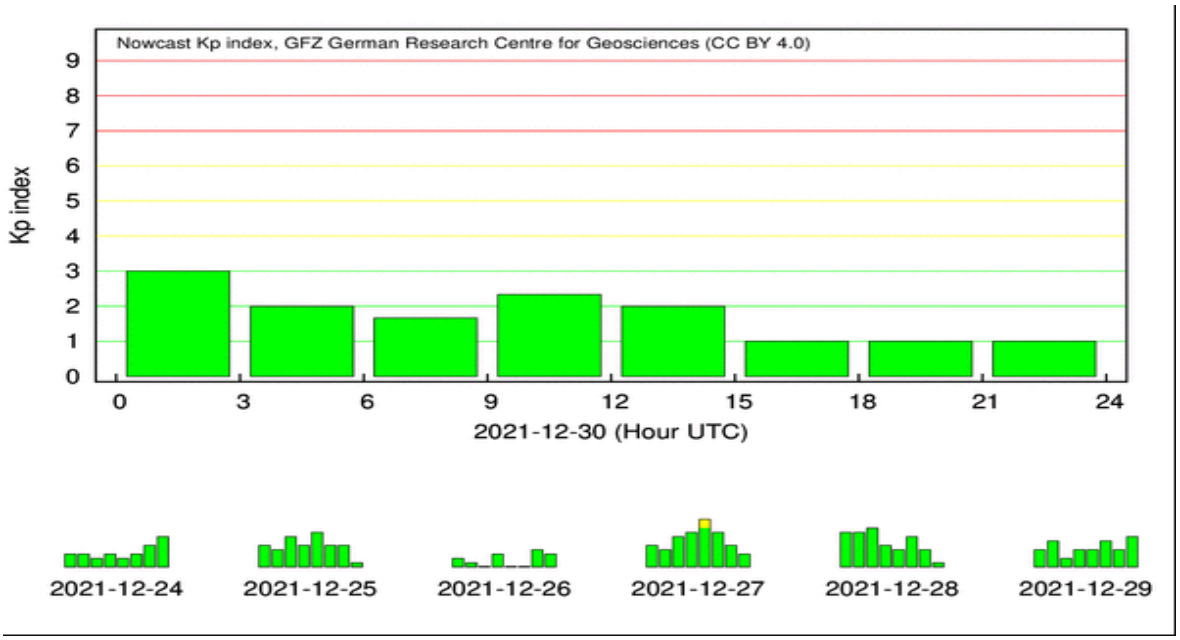
Geomagnetic activity is expected to be Quiet to Unsettled through day 1 (31 December), although Active intervals are possible. Generally Quiet with isolated Unsettled or Active intervals are possible on days 2 and 3 due to the high speed stream from coronal hole 40, although there is a small chance of G1/Minor Storms, most likely on day 2 (January)

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: Potsdam GFZ plot showing geomagnetic activity over the past 24 hours.



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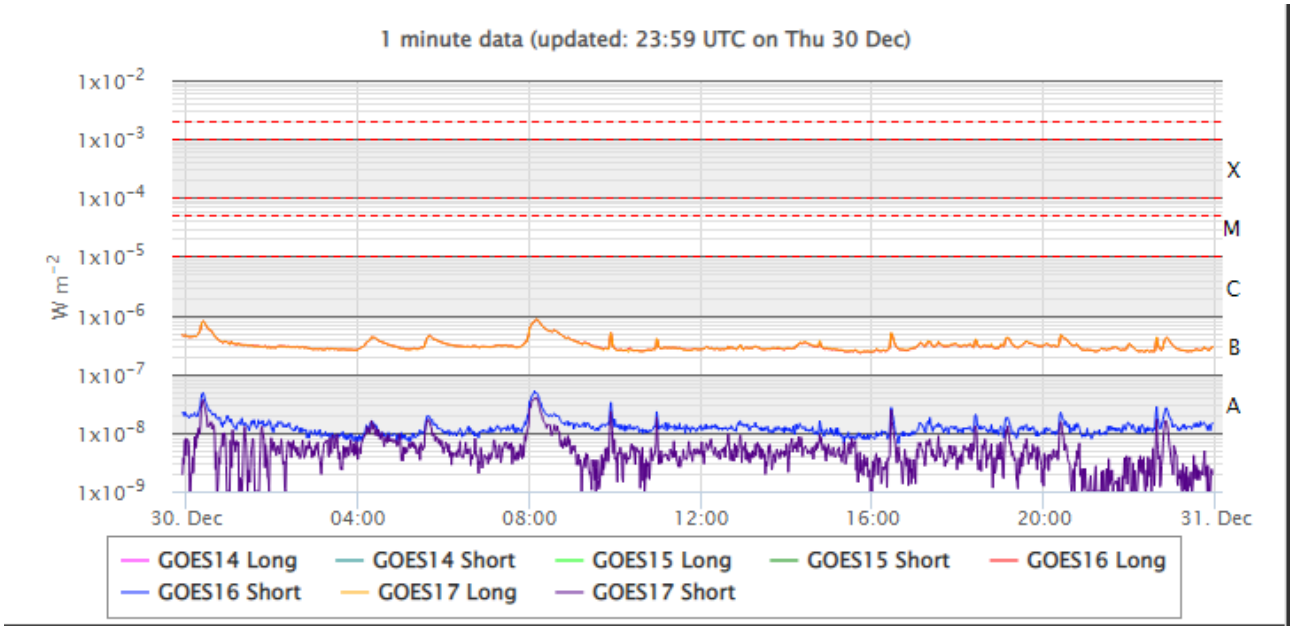
Radio Blackouts - X-Ray Flares:
Solar activity is expected to be low or very low through the next four days, with all the active regions either stable or decaying. The main contribution to any risk of M-class flares is from 2916 (Eki/Beta) which is a mature region in the southwest quadrant, although this has not flared significantly recently.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	10	10	5
Very Active	R3 to R5 X Class	No	3	3	1	1

Figure 3: GOES X-ray flux plot showing very limited flare activity with very low solar activity over the past 24 hours.



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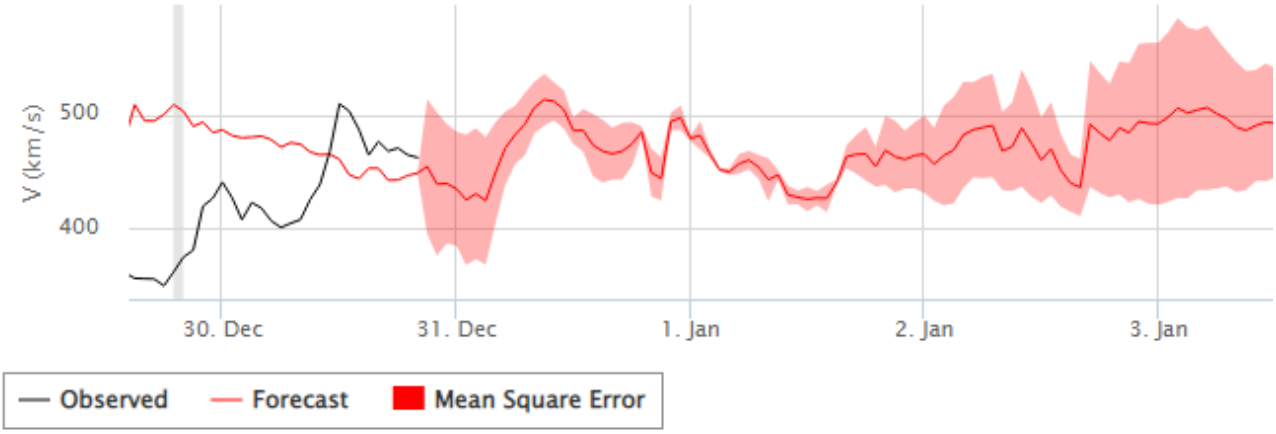
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at background levels and will most likely persist as such. There is a very slight chance of S1 from any notable flares on the disc, probably most likely from AR2916 as it rotates across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	3	3	3	3
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Met Office Solar Winds Prediction Model (SWPM) showing mostly slightly elevated solar winds for the next 4 days.



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High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2MeV) electron flux levels are at background and are likely to stay at these levels through day 1 due recent reductions due to the onset of the high speed stream from coronal hole 39. A further pattern of reduction and limited recovery is then likely on days 2 and 3 as the high speed stream from coronal hole 40 connects with the Earth.
Electron fluence is likely to rise during the next 24 to 36 hours as a result of the current high speed stream, but with the forecast geomagnetic enhancements, any increase will probably remain below the Active threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	10	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron-flux and Met Office REFM output.

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